

In the Claims:

This listing of claims will replace all prior versions, and listing, of claims in the application:

1. (Previously Presented) A patch antenna apparatus comprising:
 - a ground plane;
 - a dielectric substrate disposed above the ground plane;
 - a patch electrode provided on a surface of the dielectric substrate opposing the ground plane;
 - a ground electrode disposed between the ground plane and the dielectric substrate;
 - current-feed means connected to the patch electrode; and
 - a metal frame surrounding a peripheral surface of the dielectric substrate.
2. (Original) The patch antenna apparatus according to claim 1, wherein the height dimension of the metal frame is larger than the thickness dimension of the dielectric substrate.
3. (Original) The patch antenna apparatus according to claim 1, wherein a plan-view shape of the metal frame is substantially similar to a plan-view shape of the outer shape of the dielectric substrate.
4. (Canceled)
5. (Original) The patch antenna apparatus according to claim 1, wherein the current-feed means comprises a current-feed pin connected to the patch electrode to permit the patch antenna to receive circularly-polarized waves.
6. (Original) The patch antenna apparatus according to claim 1, wherein a distance between the dielectric substrate and the metal frame are substantially uniform.

7. (Original) The patch antenna apparatus according to claim 1, wherein an area of the dielectric substrate is larger than an area of the patch electrode.

8. (Previously Presented) A patch antenna apparatus comprising:
a ground plane;
a dielectric substrate disposed above the ground plane;
a patch electrode provided on a surface of the dielectric substrate opposing the ground plane;
a ground electrode disposed between the ground plane and the dielectric substrate;
current-feed means connected to the patch electrode; and
at least three bar-shaped conductors, each extending in a thickness direction of the dielectric substrate, arranged in the dielectric substrate along a circumference direction of the dielectric substrate, the bar-shaped conductors disposed outside the patch electrode, and lower ends of the bar-shaped conductors connected to the ground plane.

9. (Original) The patch antenna apparatus according to claim 8, wherein metal pins provided in the dielectric substrate serve as the bar-shaped conductors.

10. (Original) The patch antenna apparatus according to claim 8, wherein through-holes provided in the dielectric substrate serve as the bar-shaped conductors.

11. (Canceled)

12. (Original) The patch antenna apparatus according to claim 8, wherein the current-feed means comprises a current-feed pin connected to the patch electrode to permit the patch antenna to receive circularly-polarized waves.

13. (Original) The patch antenna apparatus according to claim 8, wherein an area of the dielectric substrate is larger than an area of the patch electrode.

14. (Original) The patch antenna apparatus according to claim 8, wherein the conductors are disposed at regular intervals along the circumference direction.

15. (Original) The patch antenna apparatus according to claim 8, wherein a plan-view shape of the dielectric substrate is substantially similar to a plan-view shape of the patch electrode.

16. (Original) The patch antenna apparatus according to claim 15, wherein the plan-view shapes of the dielectric substrate and the patch electrode are circular.

17. (Previously Presented) The patch antenna apparatus according to claim 8, wherein the bar-shaped conductors extend through the ground electrode to the ground plane.

18. (Original) The patch antenna apparatus according to claim 8, wherein the bar-shaped conductors terminate at the surface of the dielectric substrate opposing the ground plane.

19. (Original) A patch antenna apparatus comprising:
a ground plane;
a dielectric substrate disposed above the ground plane;
a patch electrode provided on a top surface of the dielectric substrate opposing the ground plane;
current-feed means connected to the patch electrode; and
at least three metal pins, each having an upright portion extending in a thickness direction of the dielectric substrate, arranged at substantially regular intervals around the dielectric substrate, a lower end of each metal pin connected to the ground plane and an upper end of the upright portion of each metal pin continues to a lateral metal member that is arranged above the dielectric substrate.

20. (Original) The patch antenna apparatus according to claim 19, wherein each metal pin is a pin member in which the upper end of the upright portion is bent and the lateral metal member extends from the bent portion.

21. (Original) The patch antenna apparatus according to claim 20, wherein the metal pin has a substantially L shape, the upper end of the upright portion being bent at a substantially right angle.

22. (Original) The patch antenna apparatus according to claim 20, wherein an end of the lateral metal member is disposed above the patch antenna.

23. (Original) The patch antenna apparatus according to claim 19, wherein a plan-view shape of the dielectric substrate is substantially similar to a plan-view shape of the patch electrode.

24. (Original) The patch antenna apparatus according to claim 23, wherein the plan-view shapes of the dielectric substrate and the patch electrode are circular.

25. (Original) The patch antenna apparatus according to claim 19, wherein the current-feed means comprises a current-feed pin connected to the patch electrode to permit the patch antenna to receive circularly-polarized waves.

26. (Original) The patch antenna apparatus according to claim 19, wherein a lateral distance between the dielectric substrate and each metal pin are substantially uniform.

27. (Original) The patch antenna apparatus according to claim 19, wherein an area of the dielectric substrate is larger than an area of the patch electrode.

28. (Original) The patch antenna apparatus according to claim 19, further comprising a ground electrode disposed between the ground plane and the dielectric substrate.

29. (Previously Presented) A patch antenna apparatus comprising:
a ground plane;
a dielectric substrate disposed on the ground plane;

a patch electrode provided on a surface of the dielectric substrate opposing the ground plane and connected to current-feed means;

a ground electrode disposed between the ground plane and the dielectric substrate; and

redirection means for redirecting a direction of radiation from the patch antenna such that a direction in which the radiation is maximized is oblique to a direction perpendicular to the surface of the dielectric substrate.

30. (Original) The patch antenna apparatus according to claim 29, wherein redirection means redirects the radiation such that the maximum radiation direction is at an elevation angle of about 30° from a plane perpendicular to the surface of the dielectric substrate.

31. (Original) The patch antenna apparatus according to claim 29, wherein redirection means redirects the maximum radiation away from the perpendicular direction.

32. (Original) The patch antenna apparatus according to claim 29, wherein the redirection means is laterally separated from and disposed at discrete intervals around the patch electrode.

33. (Original) The patch antenna apparatus according to claim 32, wherein the redirection means is laterally separated from the dielectric substrate.

34. (Original) The patch antenna apparatus according to claim 32, wherein the redirection means is disposed in the dielectric substrate.

35. (Original) The patch antenna apparatus according to claim 32, wherein the redirection means extends over the dielectric substrate.

36. (Original) The patch antenna apparatus according to claim 32, wherein the redirection means extends over the patch electrode.

37. (Original) The patch antenna apparatus according to claim 33, wherein the redirection means extends over the dielectric substrate.

38. (Original) The patch antenna apparatus according to claim 33, wherein the redirection means extends over the patch electrode.

39. (Original) The patch antenna apparatus according to claim 29, wherein the redirection means is laterally separated from and disposed continuously around the patch electrode.

40. (Original) The patch antenna apparatus according to claim 39, wherein an end of the redirection means is more distal from the ground plane than the patch electrode.

41. (Currently Amended) A patch antenna apparatus comprising:
a ground plane;
a dielectric substrate disposed above the ground plane;
a patch electrode provided on a surface of the dielectric substrate opposing the ground plane;
current-feed means connected to the patch electrode;
a metal frame surrounding a peripheral surface of the dielectric substrate, the metal frame having an opening; and
the opening of the metal frame disposed not to overlap with the dielectric substrate ~~patch electrode~~ in a plan view of the patch antenna.

42. (Previously Presented) The patch antenna apparatus according to claim 41, wherein a height dimension of the metal frame is larger than a thickness dimension of the dielectric substrate.

43. (Previously Presented) The patch antenna apparatus according to claim 41, wherein a plan-view shape of the metal frame is substantially similar to a plan-view shape of an outer shape of the dielectric substrate.

44. (Previously Presented) The patch antenna apparatus according to claim 41, further comprising a ground electrode disposed between the ground plane and the dielectric substrate.

45. (Previously Presented) The patch antenna apparatus according to claim 41, wherein the current-feed means comprises a current-feed pin connected to the patch electrode to permit the patch antenna to receive circularly-polarized waves.

46. (Previously Presented) The patch antenna apparatus according to claim 41, wherein a distance between the dielectric substrate and the metal frame are substantially uniform.

47. (Previously Presented) The patch antenna apparatus according to claim 41, wherein an area of the dielectric substrate is larger than an area of the patch electrode.